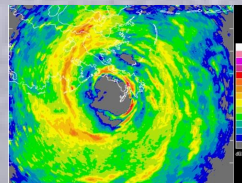


# Hurricane Impacts



Mark Powell  
AOML Program Review  
18-20 March 2008



# Key Questions

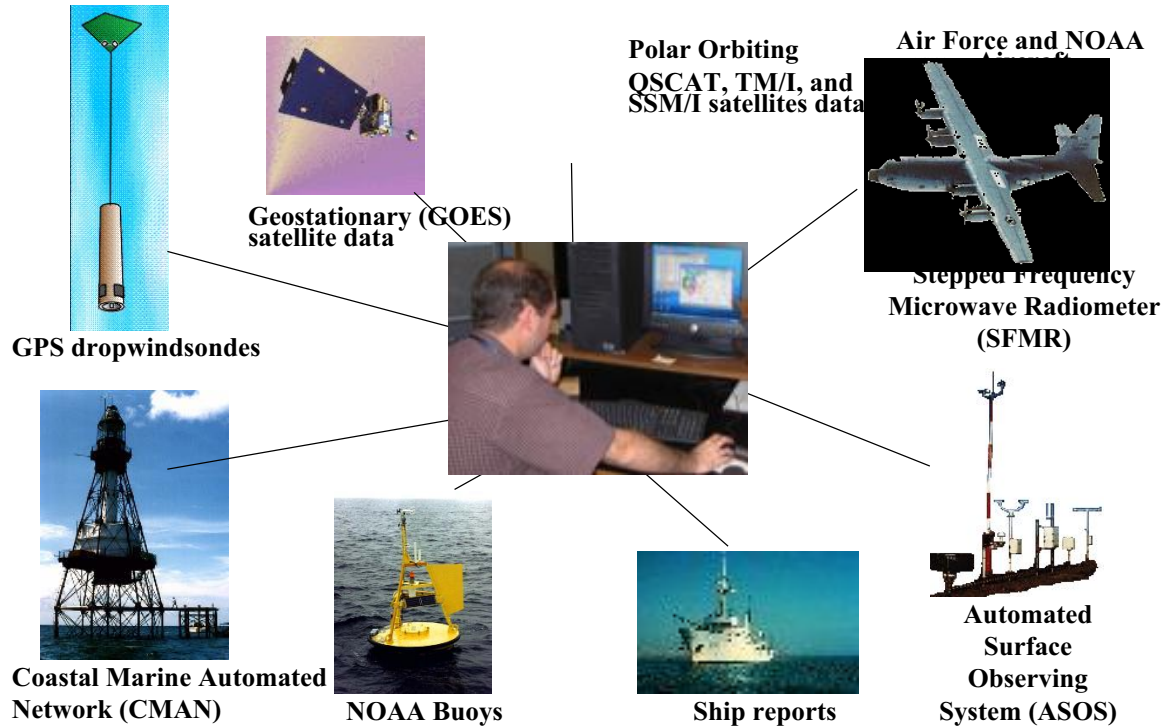
- *How do we integrate diverse observations?*
- *Do air-sea fluxes vary within a hurricane?*
- *Hurricanes are episodic events with ecosystem and climate change ramifications. How do we provide interdisciplinary mission support?*
- *What are the natural and human contributions to hurricane risk?*
- *What constitutes a “worst case” event in Florida?*

# Impacts Outline

- Integrated and Adaptive Observations / Tools
- Ecosystems, Climate
- Wind Risk and Decay Modeling
- Rainfall Flooding
- Hurricane Risk
- Winds, Waves, Storm Surge



# Integrated Observations



Tropical cyclone observations from space, sea, land, and air

Adaptive observations from aircraft and portable land-based sensors

Partnerships with public and private sectors

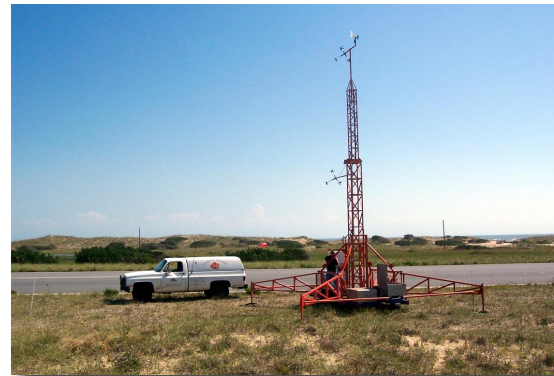


# Adaptive Observing Network

NOAA ,Air Force, NASA,  
NRL, Aircraft



TCSP, Rainex, IFEX



US Hurricane Landfall  
Coastal Network (TTU,  
UF, LSU, Clemson)

**WeatherFlow**  
Managed Weather Networks & Solutions



# Doppler Radars

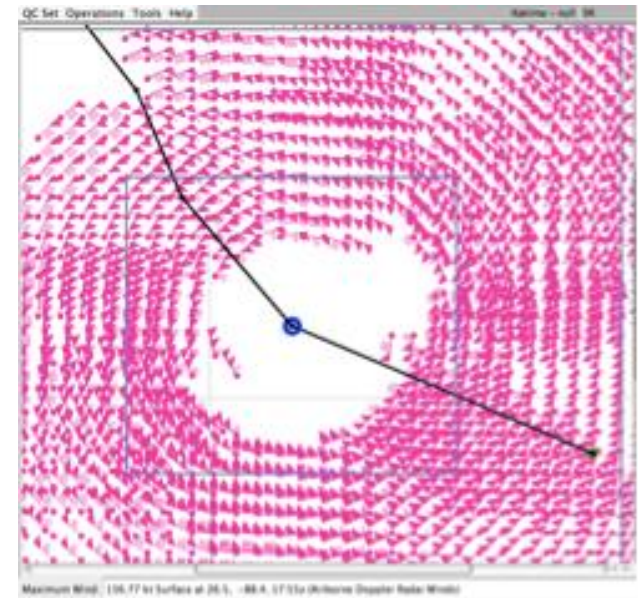
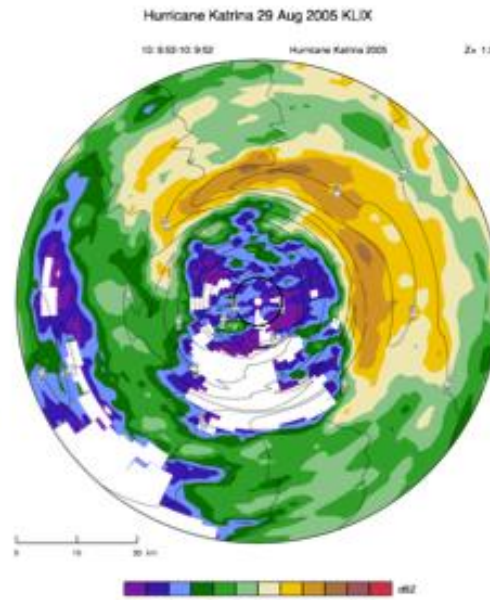
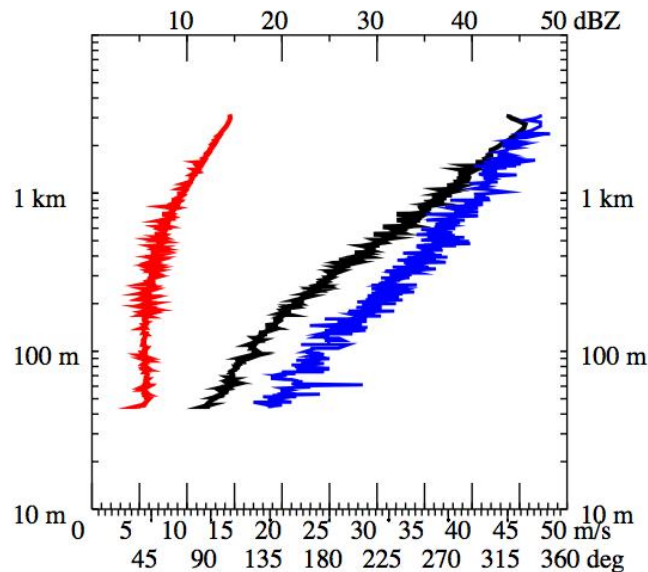
- Land-based radars and GBVTD
- Airborne radars for DA and RTMA
- Post landfall event reconstruction

KLIX20050829\_085908

VAD winds from 2.0 to 9.2 km radius.

- Windspeed- Max Doppler

- Direction







Scientists interact with observations to  
produce a real-time mesoscale analysis

Record of the event, disaster response

Basis for evaluating model performance  
(NASA Goddard, GFDL, NCAR )

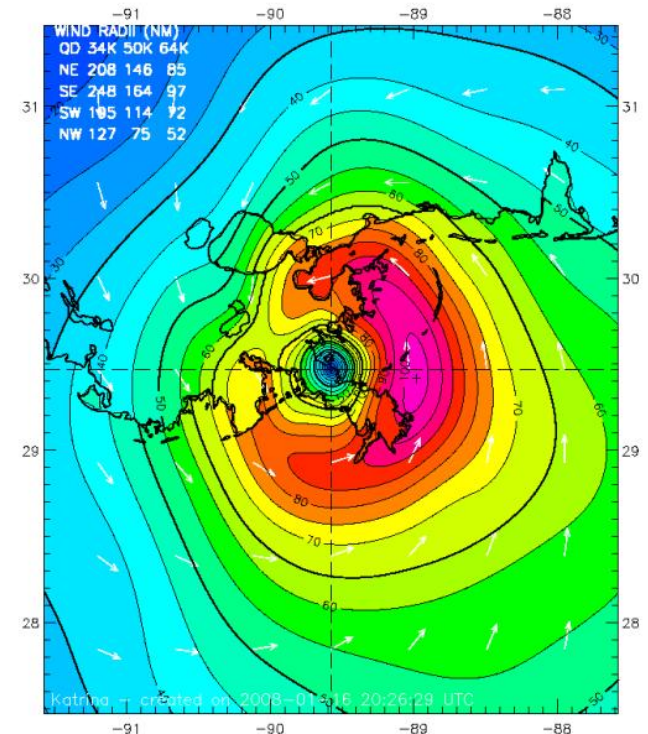
## Hurricane Katrina 1158 UTC 29 AUG 2005

Max 1-min sustained surface winds (kt)

Valid for marine exposure over water, open terrain exposure over land

Analysis based on: FCMP\_TOWER from 0942 - 1359 z; MESONET from 0937 - 1400 z; SHIP from 1010 - 1212 z;  
MADIS from 0936 - 1359 z; GOES\_SWIR from 1002 - 1002 z;  
GPSSONDE\_WL150 from 0959 - 1357 z; ASOS from 0936 - 1359 z;  
DUAL\_DOPPLER (User-defined adjusted) from 1010 - 1302 z; VAD\_88D from 0959 - 1354 z;  
OSCAR from 1100 - 1102 z; CMAN from 0936 - 1400 z;  
TAIL\_DOPPLER (User-defined adjusted) from 1020 - 1346 z; MOORED\_BUOY from 0939 - 1400 z;  
SFMR43 from 0936 - 1359 z; METAR from 0950 - 1355 z;

1158 z position interpolated from 1132 Army Corps; mslp = 923.0 mb



Integrated Kinetic Energy: for Winds > TS force: 112 TJ, for Winds > Hurricane Force: 41 TJ  
Destructive Potential Rating(0-6) Wind: 3.4, Surge/Waves: 4.9

Observed Max. Surface Wind: 102 kts, 35 nm SE of center based on 1020 z TAIL\_DOPPLER  
Analyzed Max. Wind: 102 kts, 36 nm SE of center

Uncertainty -> mean wind speed error: 6.16 kt, mean direction error: 10.70 deg  
rms wind speed error: 10.97 kt, rms direction error: 18.61 deg

Experimental research product of NOAA / AOML / Hurricane Research Division

# Ecosystem and Climate impacts

- Interdisciplinary Research Mission Support:
  - Hurricane Katrina's carbon footprint
  - Endangered species movement during hurricanes
  - Prediction of forest harvest loads
  - Sea turtle nesting patterns relative to hurricane landfalls
  - Chlorophyll enhancement in the Gulf of Mexico
  - Forest disturbance
  - Resource management of forested wetlands

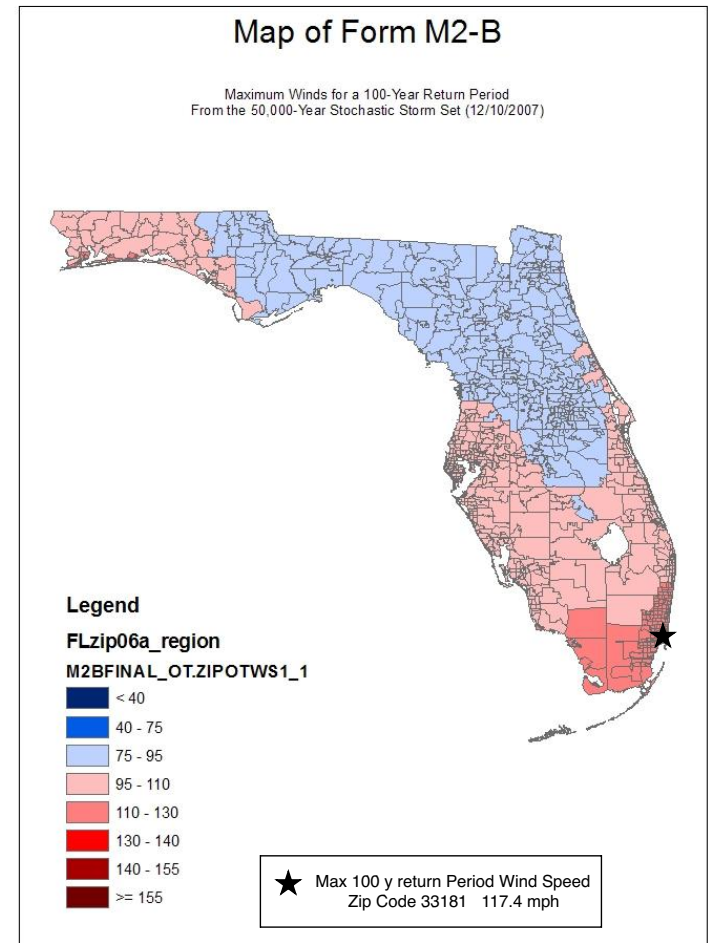


# Risk Modeling

## State of Florida

### Public Hurricane Loss Model

- State of Florida Public Hurricane Loss Model
- Thousands of years of hurricane activity modeled
- Winds input to damage model and losses aggregated
- Average annual loss computed at each zip code



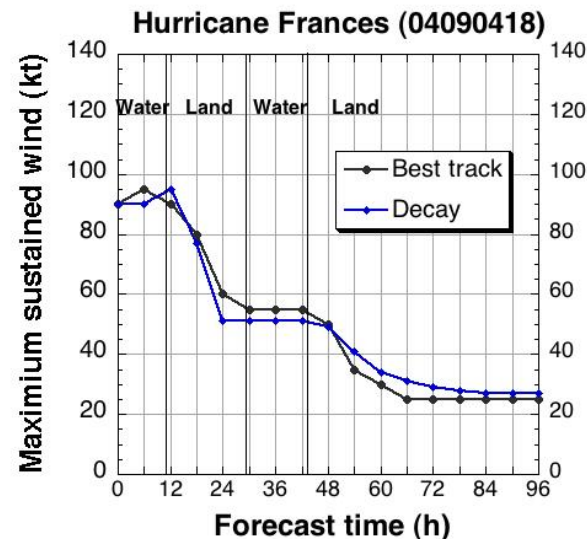
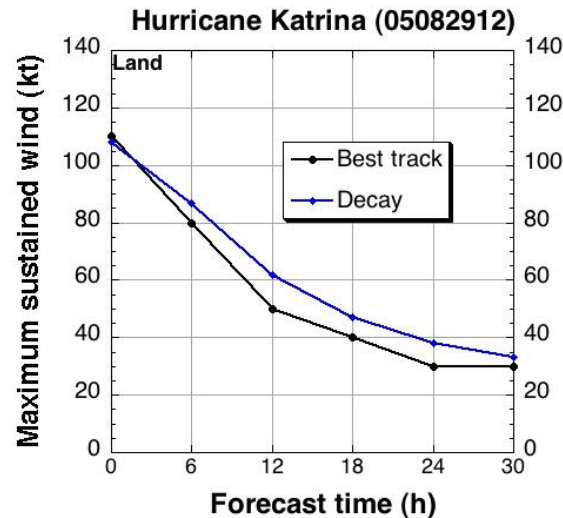
# Inland winds

## Inland Decay Model

Real-time estimates of the maximum wind and wind radii

Based upon the official TPC forecast

Transitioned to NHC

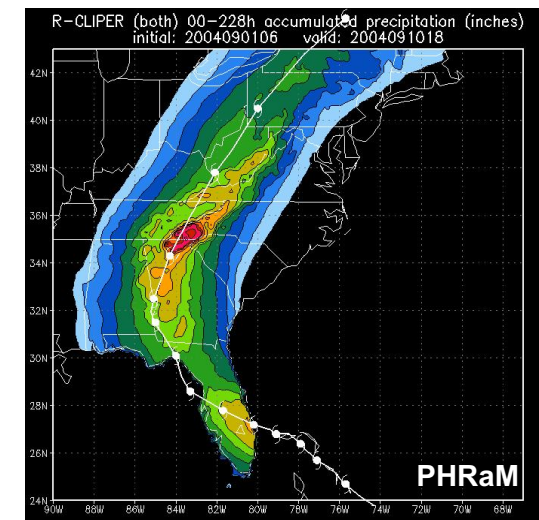
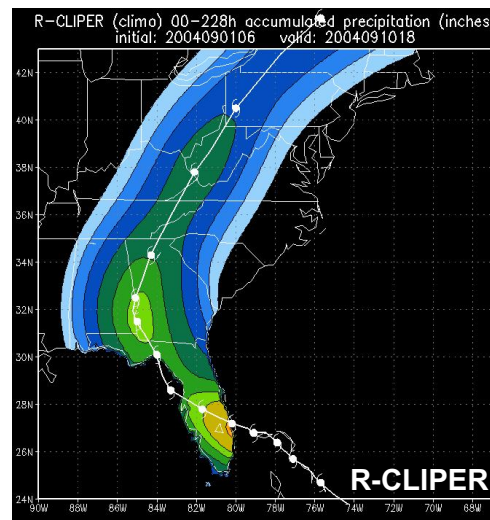
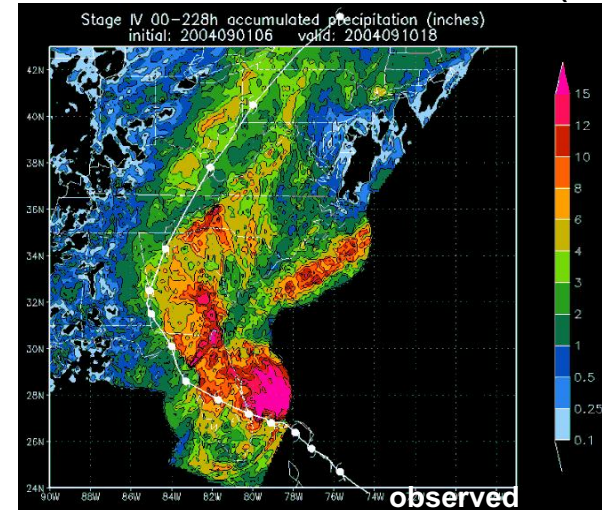


# Rainfall flooding

Storm-total rainfall for Ivan (2004)

## Parametric Hurricane Rainfall Model (PHRaM)

- Based on R-CLIPER
  - adds effect of vertical shear, terrain
- Can provide benchmark for verifying numerical model rainfall forecasts
- Successfully transitioned to operations via JHT





# Winds, Waves, Surge

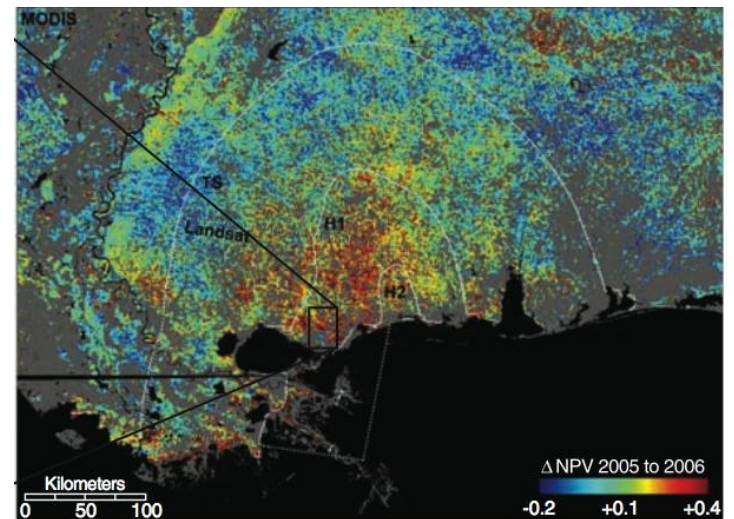
- Wind field surface stress forces the waves and surge
- Establish the surface friction thru GPS sonde research
- Gridded wind fields help drive surge, wave, damage models
- Alternative measures of the storm impact to improve warning process and evaluate models



BAMS 2007



20 March 2003



SCIENCE VOL 318 16 NOVEMBER 2007  
Chambers, Tulane



**The aerodynamic roughness of the sea  
depends on sea state:**

**Wind Speed**

**Bubbles**

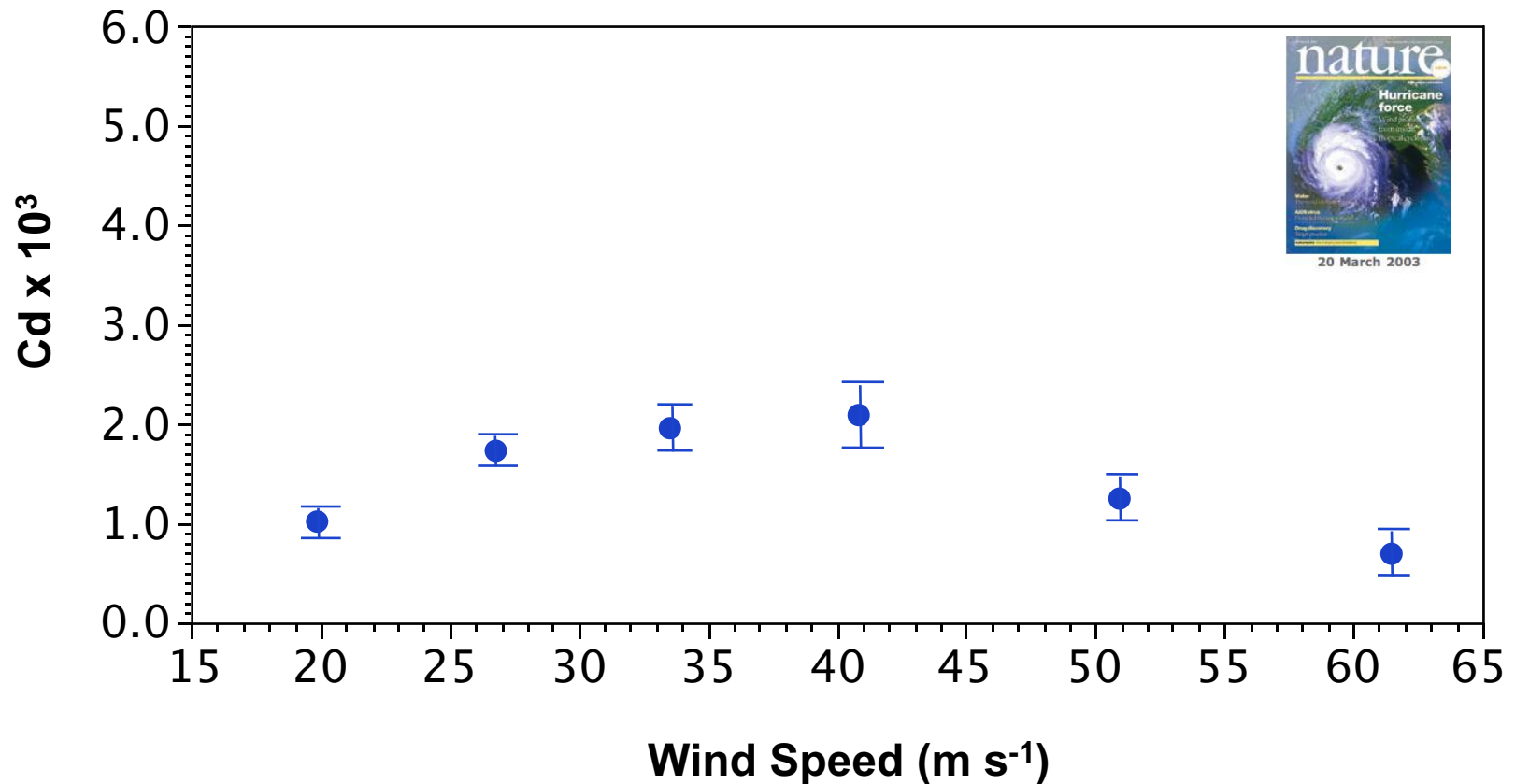
**Sea Spray**

**wave steepness**

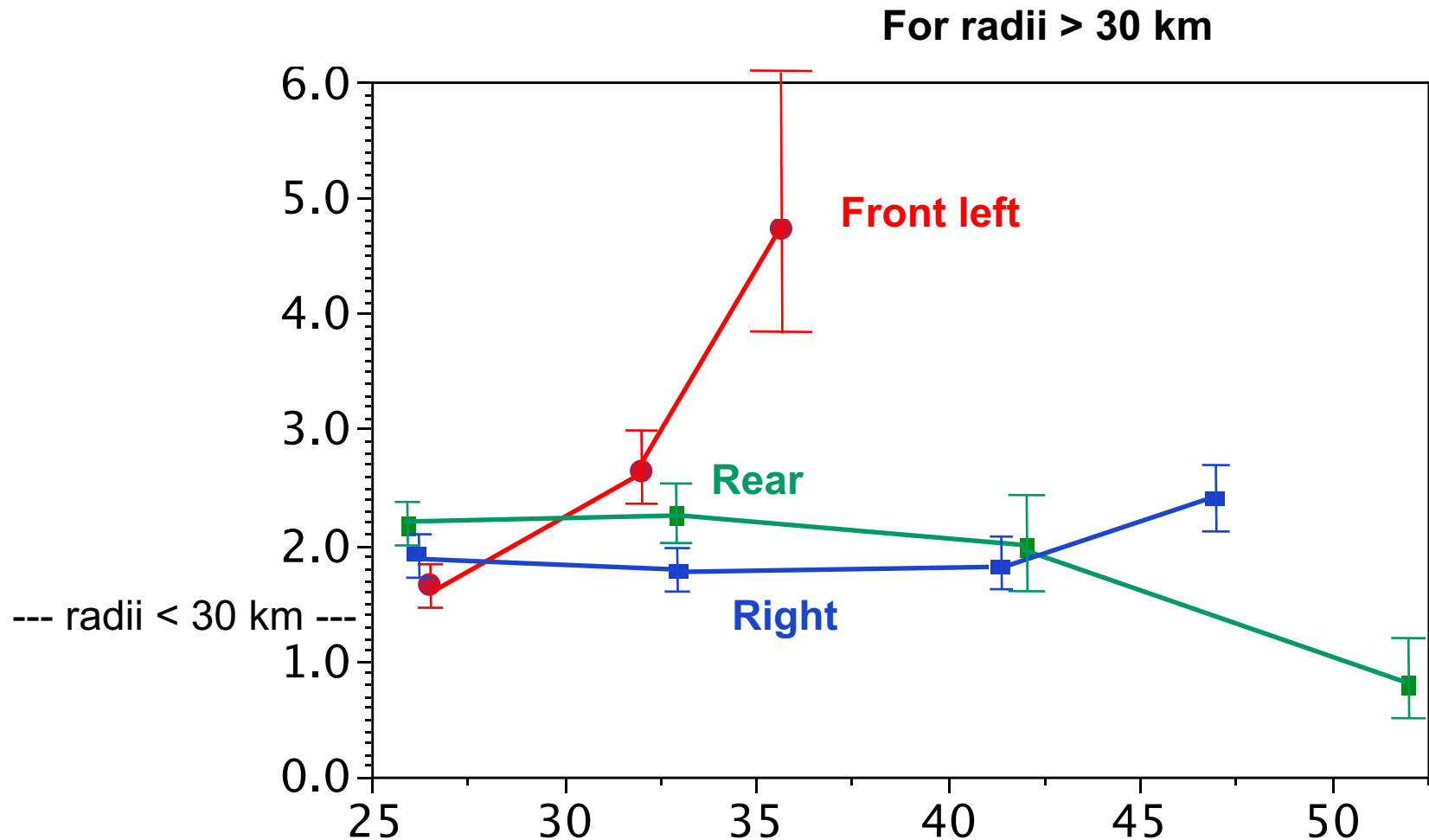
**wave motion relative to the wind**

**These factors vary with position in the  
storm**

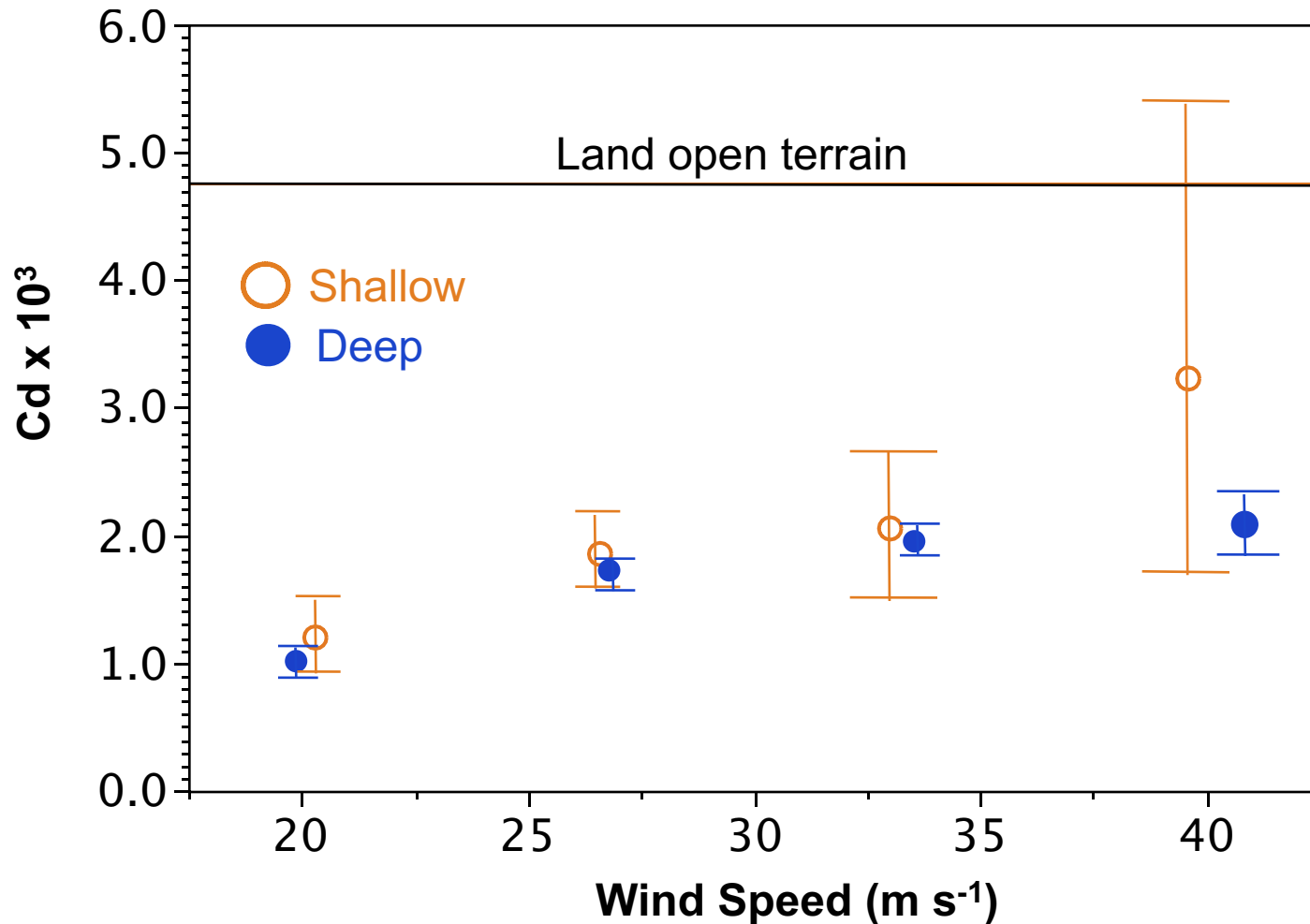
# Drag Coefficient: wind speed



# Drag Coefficient: storm radius, azimuth



# Drag Coefficient: water depth





A satellite image of Earth from space, showing a large hurricane over the ocean. The hurricane has a distinct eye and spiral cloud bands. The ocean surface is visible with some wave patterns. The horizon of the Earth is at the top of the image.

# QUESTIONS?



# Background Material

Link to AOML-HRD Hurricane Impacts web page

[http://www.aoml.noaa.gov/hrd/programs\\_sub/  
Hurricane\\_WindsLandfall.html](http://www.aoml.noaa.gov/hrd/programs_sub/Hurricane_WindsLandfall.html)

